Claims

1. A sol-gel coating material comprising

(A) an acrylate copolymer solution comprising at least one acrylate copolymer (A1) preparable by copolymerizing at least the following monomers:

a1) at least one (meth)acrylic ester which is substantially free of acid groups,

a2) at least one ethylenically unsaturated monomer which bears at least one hydroxyl group per molecule and is substantially free of acid groups, and

a3) at least one ethylenically unsaturated monomer which bears per molecule at least one acid group which is convertible to the corresponding acid anion group;

(B) a stock coating material preparable by hydrolyzing and condensing at least one hydrolyzable silane (B1) of the general formula I

$$SiR_4 \qquad (I)$$

where the variable R has the following meaning:

R = hydrolyzable groups, hydroxyl groups and nonhydrolyzable groups with the proviso that there is at least one and there are preferably at least two hydrolyzable group(s);

and

(C) a sol preparable by hydrolyzing, condensing and complexing at least one hydrolyzable silane (B1) of the general formula I and at least one hydrolyzable metal compound (C1) of the general formula II

$$MR_n \quad (II)$$

where the variables and the index have the following meaning:

M = aluminum, titanium or zirconium,

R = hydrolyzable groups, hydroxyl groups and nonhydrolyzable groups with the proviso that there is at least one and there are preferably

at least two hydrolyzable group(s), and

n = 3 or 4.

2. The sol-gel coating material of claim 1, characterized in that it is aromatics free.

3. The sol-gel coating material of claim 1 or 2, characterized in that it comprises, in each case based on its total amount, 5 to 40, preferably 10 to 35 and especially 15 to 30 weight % of the acrylate copolymer solution (A), 5 to 40, preferably 10 to 35 and especially 15 to 30 weight % of the stock coating material (B) and also 1 to 15, preferably 2 to 10 and especially 3 to 8 weight % of the sol (C).

4. The sol-gel coating material of any of claims 1 to 3, characterized in that the solids contents of the constituents (A), (B) and (C) are in a weight ratio of (A):(B):(C) of

- 0.5 to 5:1 to 10:1,

- preferably 1 to 4:2 to 8:1 and

- especially 1.5 to 3:3 to 6:1.

5. The sol-gel coating material of any of claims 1 to 4, characterized in that

- the nonhydrolyzable groups R are alkyl groups, especially of 1 to 4 carbon atoms; alkenyl groups, especially of 2 to 4 carbon atoms; alkynyl groups, especially of 2 to 4 carbon atoms; and/or aryl groups, especially of 6 to 10 carbon atoms; and

- the hydrolyzable groups R are hydrogen atoms, alkoxy groups, especially of 1 to 20 carbon atoms; alkoxy-substituted alkoxy groups of 3 to 20 carbon atoms; acyloxy groups, especially of 1 to 4 carbon atoms; alkylcarbonyl groups, especially of 2 to 6 carbon atoms.

6. The sol-gel coating material of claim 5, characterized in that

- the hydrolyzable groups R are methoxy, ethoxy, n-propoxy, i-propoxy, n-butoxy, sec-butoxy, beta-methoxyethoxy, acetoxy, propionyloxy and/or acetyl groups and the

- nonhydrolyzable groups R are methyl, ethyl, propyl, butyl, vinyl, 1-propenyl, 2-propenyl,

butenyl, acetylenyl, propargyl, phenyl and/or naphthyl groups.

7. The sol-gel coating material of any of claims 1 to 6, characterized in that the nonhydrolyzable groups R contain at least one functional group, especially at least one epoxide group, amino group, olefinically unsaturated group, mercapto group and/or isocyanate group and/or their reaction products with further reactive compounds.

8. The sol-gel coating material of any of claims 1 to 7, characterized in that complexing is effected using organic compounds which form chelate ligands.

9. The sol-gel coating material of any of claims 1 to 8, characterized in that it is a sol-gel clearcoat material.

10. The use of the sol-gel coating material of any of claims 1 to 9 for producing mar-resistant sol-gel coatings, especially for single-coat or multicoat paint systems.

11. The use of the sol-gel coating material of claim 10, characterized in that cured single-coat or multicoat paint systems are concerned.

12. The use of the sol-gel coating material of claim 10 or 11, characterized in that the paint systems are vehicle original equipment manufacturing coatings, vehicle repair coatings, industrial coatings, including container coatings, plastics coatings and furniture coatings.

13. A process for producing mar-resistant sol-gel coatings on single-coat or multicoat paint systems by

(i) applying a single-coat or multicoat paint system to a primed or unprimed substrate,

(ii) applying a sol-gel coating material atop the single-coat or multicoat paint system and

(iii) curing the sol-gel coating material,

characterized in that a sol-gel coating material as claimed in any of claims 1 to 9 is used.

14. The process of claim 13, characterized in that the applied sol-gel coating material is cured by irradiation with intermediate IR radiation.

15. The process of claim 13 or 14, characterized in that the single-coat or multicoat paint system has been completely cured.

16. The process of any of claims 13 to 15, characterized in that the paint systems are automotive original equipment manufacturing coatings, automotive repair coatings, industrial coatings, including container coatings, plastics coatings and furniture coatings.

17. Sol-gel coatings preparable from a sol-gel coating material as claimed in any of claims 1 to 9 and/or by the process of any of claims 13 to 16.

18. Substrates comprising at least one sol-gel coating as claimed in claim 18.